

This Page Is Inserted by IFW Operations  
and is not a part of the Official Record

## **BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning documents *will not* correct images,  
please do not report the images to the  
Image Problem Mailbox.**

(18)



Europäisches Patentamt  
European Patent Office  
Office européen des brevets

(11) Publication number:

**0 002 848**  
**B1**

(12)

## EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **05.08.81**

(51) Int. Cl.<sup>3</sup>: **H 01 J 61/54**

(21) Application number: **78200339.6**

(22) Date of filing: **04.12.78**

(54) **Electrical high-pressure metal vapour discharge lamp.**

(30) Priority: **16.12.77 NL 7713950**

(43) Date of publication of application:  
**11.07.79 Bulletin 79/14**

(45) Publication of the grant of the European patent:  
**05.08.81 Bulletin 81/31**

(84) Designated Contracting States:  
**BE DE FR GB NL**

(56) References cited:  
**DE - A - 1 764 866**  
**US - A - 2 542 345**  
**US - A - 4 047 064**  
**US - A - 4 065 370**

(73) Proprietor: **N.V. Philips' Gloeilampenfabrieken**  
**Pieter Zeemanstraat 6**  
**NL-5621 CT Eindhoven (NL)**

(72) Inventor: **Jacobs, Cornelis Adrianus Joannes**  
**c/o Int. Octrooibureau B.V. 6 Prof. Holstlaan**  
**NL-5600 Eindhoven (NL)**  
Inventor: **Van Esdonk, Johannes**  
**c/o Int. Octrooibureau B.V. 6 Prof. Holstlaan**  
**NL-5600 Eindhoven (NL)**  
Inventor: **Ruts, Josephus Maria**  
**c/o Int. Octrooibureau B.V. 6 Prof. Holstlaan**  
**NL-5600 Eindhoven (NL)**

(74) Representative: **Van Heemskerck Veeckens, Johan**  
**Fredrik Theodoor et al.**  
**INTERNATIONAAL OCTROOIBUREAU B.V. Prof.**  
**Holstlaan 6**  
**NL-5656 AA Eindhoven (NL)**

**EP 0 002 848 B1**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European patent convention).

Courier Press, Leamington Spa, England.

## Electrical high-pressure metal vapour discharge lamp

The invention relates to an electrical high-pressure metal vapour discharge lamp comprising an elongate discharge tube provided near each of its two ends with a respective internal main electrode, the wall of the discharge tube consisting substantially wholly of aluminium oxide, a strip-shaped coating being present over at least a portion of the outer surface of the wall of the discharge tube, this coating containing a first electrically conductive elementary material as well as a second material counteracting evaporation of the first material, and in which at least part of the first material is in direct contact with the aluminium oxide, the strip-shaped coating being fastened over substantially its whole length to the discharge tube and forming in use, part of a starting auxiliary device for starting a discharge between the main electrodes.

A prior art electrical high-pressure metal vapour discharge lamp of the type defined above is, for example, disclosed in Dutch Patent Application no. 7304860. A drawback of that known high-pressure metal vapour discharge lamp is that, for promoting the starting of a discharge between the main electrodes, the strip-shaped wall coating is connected to an internal auxiliary electrode of the discharge tube. This requires an additional electric feed-through through the wall of the discharge tube.

It is an object of the invention to provide a lamp of the type defined in the preamble in which the strip-shaped wall coating, provided on the outer side of the discharge tube wall, is the auxiliary electrode of the discharge tube, such that this strip-shaped coating does not substantially intercept visible light generated in the discharge tube and has relative low ohmic resistance.

An electrical high-pressure metal vapour discharge lamp according to the invention is characterized in that the strip-shaped coating extends along substantially the whole path between the main electrodes, and in that this strip-shaped coating has a width smaller than 0.5 mm over at least 90% of its length and the first material of the strip-shaped coating consists for 16 to 90% by volume of an element from the group molybdenum, tungsten, tantalum, niobium and carbon, and the second material of the strip-shaped coating consists of one or more oxides which, at a temperature of 1500 Kelvin, have vapour pressure below  $1.3 \cdot 10^{-4}$  Pa.

The narrow width, over the greater portion of the length of this auxiliary electrode implies that the auxiliary electrode intercepts the light generated in the discharge tube to a very small extent only. This invention has furthermore the advantage that more of the first material can be included in the strip-shaped coating than would be possible in the case of a solid strip on the

discharge tube. In addition, it is a good electrically-conducting material. The following should be noted by way of explanation. With the narrow width of not more than 0.5 mm of the strip-shaped coating, a sufficient low ohmic resistance thereof per running centimeter of length can — in the case of a solid metal — only be realized with a fairly thick layer of that metal. However, a very thick layer results in a poor adhesion of that metal to the discharge tube wall which mainly consists of aluminium oxide. This is caused by differences in the coefficients of expansion. By including in the strip-shaped coating oxides, a sufficiently low ohmic resistance of the strip-shaped coating can be combined with a proper adhesion to the discharge tube wall. By taking oxides which at a temperature of 1500 Kelvin have a low vapour pressure, the foregoing is combined with keeping the composition of the strip-shaped coating fairly constant throughout the life of the lamp. This results in the ohmic resistance of the coating remaining low during the life of the lamp.

The strip-shaped coating may have a width exceeding 0.5 mm for a short length, for example, where there is a connecting terminal for electrically connecting the strip-shaped coating to the circuit of the lamp.

A discharge lamp provided with a strip-shaped coating on the outside of the discharge tube, which extends along the whole path between the main electrodes, is known in itself from USP 2.542.345. The width of the coating of this known lamp is about 1 mm. The known lamp is a low pressure metal vapour discharge lamp of which the wall of the discharge tube is made of glass and will have a temperature during operation that does not exceed 100°C (375 K). Furthermore the strip-shaped coating consists of a solid metal conductor covered by a second material suitable for adherence to the discharge tube. This implies that the electrically conduction material is not in direct contact with the discharge tube.

An advantage of a direct contact of the electrically conductive material of the auxiliary electrode with the wall of the discharge tube is that, compared with the above prior art lamp, it gives a more reliable ignition of the discharge in the discharge tube.

In an improvement of a lamp according to the above-mentioned embodiment, the first material of the strip-shaped coating is molybdenum or carbon, this first material being uniformly distributed in the second material of the strip-shaped coating. An advantage of this improvement is that a low degree of evaporation can be combined with a high electrical conductivity of the strip-shaped coating.

In a further improvement of that lamp the

strip-shaped coating consists, by volume, of approximately 80% Molybdenum + 10%  $\text{Al}_2\text{O}_3$  + 10% CaO. With such a strip-shaped coating it is possible to obtain, next to the above-mentioned advantages of a low evaporation and a high electrical conductivity, a very good adhesion to the discharge tube wall.

The discharge lamp is, for example, a high-pressure sodium vapour discharge lamp the discharge tube of which also contains a starting gas, for example xenon, at a filling pressure of less than 2.7 kPa.

In an embodiment of an electrical high-pressure metal vapour discharge lamp according to the invention, which is implemented as a high-pressure sodium vapour discharge lamp, the discharge tube contains sodium and xenon, the filling pressure of the xenon exceeding 6.7 kPa, the circumference of a transverse cross-section through the discharge tube being between 10 and 40 mm. An advantage of this embodiment is that it may furnish a lamp which combines a high luminous efficacy with a relatively low starting voltage, and wherein the interception of light by the strip-shaped coating is very small only.

A high-pressure discharge lamp according to the invention may comprise a discharge tube, the strip-shaped coating of which is not electrically connected to the lamp circuit. In that case the strip-shaped coating has a floating potential in use, preferably, however, in a high-pressure metal vapour discharge lamp according to the invention, the strip-shaped coating is electrically connected to one of the main electrodes of the discharge tube. An advantage of this is that during the starting procedure of the lamp the difference in potential between the strip-shaped coating — which then operates as an auxiliary electrode — and the main electrode of the discharge tube not connected thereto can be substantially equal to the mains voltage. As a rule this promotes the creation of ions and electrons in the discharge tube which facilitates the creation of a discharge between the main electrodes of the discharge tube. All this implies that the minimum voltage between the main electrodes for starting a discharge between these electrodes is then relatively low.

Some embodiments of lamps according to the invention will now be further explained with reference to a drawing in which:

Figure 1 shows an elevational view, partly in cross-section, of a high-pressure sodium vapour discharge lamp according to the invention;

Figure 2 shows a cross-section — not to scale — through a variant of a discharge tube for the lamp of Figure 1.

In Figure 1 reference numeral 1 denotes a discharge tube whose wall consists mainly of densely sintered aluminium oxide. This tube is located in an outer bulb 2. Reference numeral 3 denotes a base of the lamp. The discharge tube 1 comprises two internal main electrodes 4 and

5, respectively, located near the ends of this discharge tube. Via a feed-through 6 the main electrode 4 is connected to a metal conductor 7 connected to a pole wire 8 which is curved around the discharge tube 1. This form of the pole wire 8 has the advantage that annoying shadows are avoided. Pole wire 8 is electrically connected to a contact of the base 3 of the lamp. An extended portion 9 of the pole wire 8 serves, together with a support 10, for supporting and centring the discharge tube 1 in the outer bulb 2. Via a tubular feed-through 11 the main electrode 5 is mechanically fastened to a metal conductor 12. The electrical connection is effected via a metal conductor 13. The other end of the conductor 12 is connected to a further contact in the base 3 of the lamp.

In addition, the discharge tube is provided with a strip-shaped external auxiliary electrode 20 in the form of a local coating on the outer surface of the discharge tube 1. The auxiliary electrode 20 extends over substantially the whole distance between the main electrodes 4 and 5. The auxiliary electrode is approximately 0.2 mm wide, its composition by volume is: a mixture of 80% Molybdenum, 10%  $\text{Al}_2\text{O}_3$  and 10% CaO. The two mentioned oxides  $\text{Al}_2\text{O}_3$  and CaO have, at a temperature of 1500 Kelvin, a vapour pressure below  $1.3 \cdot 10^{-4}$  Pa. Near the main electrode 5 the discharge tube 1 comprises a conducting nickel sleeve 21 which also extends over the auxiliary electrode 20 and is in electrical contact therewith. A strip 22, also of nickel, connects the sleeve 21 to an electrode of a capacitor 23, disposed in the space between the discharge tube 1 and the outer bulb 2. The other electrode of capacitor 23 is constituted by a portion of the metal conductor 13 which provides the electrical connection between the main electrode 5 and the conductor 12.

The discharge tube 1 contains both sodium and mercury as well as xenon. The xenon pressure at 300 Kelvin is approximately 27 kPa. The space between the discharge tube 1 and the outer bulb 2 is evacuated.

The described lamp is, for example ignited by means of a starter (not shown) provided with a thyristor, for example as disclosed in Dutch Patent Application no. 6904456.

In the operating condition of the lamp shown in Figure 1 the lamp is connected through an inductive stabilisation impedance of approximately 0.3 Henry to an a.c. mains supply of approximately 220 Volts, 50 Hertz. Further details of the described lamp are included in the following table. The temperature of the coldest spot in the discharge tube 1 is — in the operating condition of the lamp according to the invention — approximately 1000 Kelvin. A sodium vapour pressure in the discharge tube 1 of approximately 17 kPa corresponds therewith. The average temperature within the discharge tube 1 in the operating condition of the lamp is approximately 2400 Kelvin. The average

temperature of the wall of the discharge tube is approximately 1500 Kelvin. At this temperature of 1500 Kelvin the vapour pressure of the oxides of the strip-shaped auxiliary electrode is

— as already mentioned above — small. So there is only a low degree of evaporation of said oxides.

	Lamp according to the invention
Power (in watts)	150
Operating voltage (in volts)	100
Inside diameter of the discharge tube (in mm)	4.5
Circumference of cross-section (in mm) of the discharge tube approx.	20
Main electrode spacing (in mm)	63
Weight of the amalgam (in mgram)	10
Weight ratio mercury/sodium	2.7
Xenon pressure cold (in torr)	200
Xenon pressure during operation (in torr)	1600
Luminous efficacy (lumens /watt)	115
General colour rendering Index $R_a$	19

The voltage required between the main electrodes 4 and 5 for starting the discharge is in the present case approximately 2 kVolts.

Without the strip 20 the voltage required between the main electrodes 4 and 5 — for igniting the discharge — would be much greater, namely: approximately 6 kVolts.

The strip-shaped coating 20 of Figure 1 is approximately 35 microns thick. Its ohmic resistance per running centimetre is approximately 0.1 kOhm.

The strip-shaped coating 20 is applied to the wall of the discharge tube by means of a pen. For this purpose this pen is first dipped into a suspension of 80% molybdenum powder with

10% aluminium oxide and 10% calcium oxide in butyl acetate. After the coating has been applied a firing operation is performed at 1600 Kelvin for 30 minutes in a reducing atmosphere. This results in a proper adhesion to the wall of the discharge tube 1 over the full length of the strip-shaped coating 20.

In a case where the first material of the strip-shaped coating is carbon, that strip-shaped coating can, for example, also be applied to the discharge tube by means of a pen.

Also other processes of realizing the strip-shaped coating on the wall of the discharge tube are conceivable.

Figure 2 shows a perpendicular cross-section

100 of a second discharge tube, enlarged three times relative to that of the discharge tube 1 of Figure 1. Also tube 100 consists mainly of aluminium oxide. A strip-shaped molybdenum coating 101 is provided on tube 100. A tungsten top coating 102 is applied over coating 101. The full width of the strip is approximately 0.2 mm. To indicate the various layers, the strip is not drawn to scale in Figure 2.

An advantage of the described strip-shaped coatings in a lamp according to the invention — as opposed to starting wires — is that the strip-shaped coatings are always very close to the main electrode path without requiring an additional measure such as subjecting it to a tensile load — as is the case with starting wires.

### Claims

1. An electrical high-pressure metal vapour discharge lamp comprising an elongate discharge tube (1) provided near each of its two ends with a respective internal main electrode (4,5), the wall of the discharge tube consisting substantially wholly of aluminium oxide, a strip-shaped coating (20) being present over at least a portion of the outer surface of the wall of the discharge tube, this coating containing a first electrically conductive elementary material as well as a second material counteracting evaporation of the first material and in which at least part of the first material is in direct contact with the aluminium oxide, the strip-shaped coating being fastened over substantially its whole length to the discharge tube and forming, in use, part of a starting auxiliary device for starting a discharge between the main electrodes, characterized in that the strip-shaped coating extends along substantially the whole path between the main electrodes, and in that this strip-shaped coating has a width smaller than 0.5 mm over at least 90% of its length, and the first material of the strip-shaped coating consists for 16 to 90% by volume of an element from the group molybdenum, tungsten, tantalum, niobium and carbon, and the second material of that strip-shaped coating consists of one or more oxides which, at a temperature of 1500 Kelvin, have vapour pressures below  $1.3 \cdot 10^{-4}$  Pa.

2. An electrical high-pressure metal vapour discharge lamp as claimed in claim 1, characterized in that the first material is molybdenum or carbon, this first material being uniformly distributed in the second material of the strip-shaped coating.

3. An electrical high-pressure metal vapour discharge lamp as claimed in claim 2, characterized in that the strip-shaped coating consists of substantially 80% Molybdenum + 10%  $Al_2O_3$  + 10% CaO by volume.

4. An electrical high-pressure metal vapour discharge lamp as claimed in any of claims 1, 2 or 3, the lamp being a high-pressure sodium vapour discharge lamp, the discharge tube

containing sodium and xenon, the filling pressure of the xenon exceeding 6.7 kPa, characterized in that the circumference of a transverse cross-section (100) through the discharge tube is between 10 mm and 40 mm.

5. An electrical high-pressure metal vapour discharge lamp as claimed in any of claims 1, 2, 3 or 4, characterized in that the strip-shaped coating is electrically connected to one of the main electrodes of the discharge tube.

### Patentansprüche

1. Elektrische Hochdruckmetaldampfentladungslampe mit einem länglichen Entladungsrohr (1), das nahe jedem seiner beiden Enden mit einer inneren Hauptelektrode (4, 5) versehen ist und dessen Wand nahezu vollständig aus Aluminiumoxyd besteht und auf wenigstens einem Teil der Aussenseite eine streifenförmige Bedeckung aufweist, die einen ersten elektrisch leitenden elementaren Werkstoff sowie einen zweiten Werkstoff enthält, der ein Abdampfen des ersten Werkstoffs vermeidet, wobei wenigstens ein Teil des ersten Werkstoffs mit dem Aluminiumoxyd in direktem Kontakt steht, die streifenförmige Bedeckung auf nahezu ihrer vollen Länge am Entladungsrohr befestigt ist und im Betrieb einen Teil einer Zündhilfsanordnung zum Starten der Entladung zwischen den Hauptelektroden bildet, dadurch gekennzeichnet, dass sich die streifenförmige Bedeckung nahezu entlang der ganzen Strecke zwischen den Hauptelektroden erstreckt und auf mindestens 90% ihrer Länge eine Breite hat, die kleiner ist als 0,5 mm und dass die Zusammensetzung des ersten Werkstoffs der streifenförmigen Bedeckung zu 16 bis 90 Volumenprozent aus einem Element der Gruppe Molybdän, Wolfram, Tantal, Niob und Kohlenstoff und der zweite Werkstoff dieser streifenförmigen Bedeckung aus einem oder mehreren Oxyden besteht, die bei einer Temperatur von 1500 K Dampfdrücke aufweisen, die  $1,3 \cdot 10^{-4}$  Pa unterschreiten.

2. Elektrische Hochdruckmetaldampfentladungslampe nach Anspruch 1, dadurch gekennzeichnet, dass der erste Werkstoff Molybdän oder Kohlenstoff und dieser erste Werkstoff in dem weiteren Material der streifenförmigen Bedeckung homogen verteilt ist.

3. Elektrische Hochdruckmetaldampfentladungslampe nach Anspruch 2, dadurch gekennzeichnet, dass die streifenförmige Bedeckung aus etwa 80 Vol.% Molybdän + 10 Vol.%  $Al_2O_3$  + 10 Vol.% CaO besteht.

4. Elektrische Hochdruckmetaldampfentladungslampe nach Anspruch 1, 2 oder 3, die eine Hochdrucknatriumdampfentladungslampe ist, deren Entladungsrohr Natrium und Xenon enthält wobei der Fülldruck des Xenons 6,7 kPa überschreitet, dadurch gekennzeichnet, dass der Umfang eines Querschnitts (100) des Entladungsrohrs zwischen 10 und 40 mm liegt.

5. Elektrische Hochdruckmetaldampfent-

ladungslampe nach Anspruch 1, 2, 3 oder 4, dadurch gekennzeichnet, dass die streifenförmige Bedeckung elektrisch an eine der Hauptelektroden des Entladungsrohrs angeschlossen ist.

#### Revendications

1. Lampe électrique à décharge dans une vapeur de métal à haute pression, munie d'un tube à décharge allongé (1) qui, pres de chacune de ses extrémités, est muni d'une électrode principale interne (4, 5) et dont la paroi est réalisée quasi entièrement en oxyde d'aluminium, alors que sur au moins une partie de la surface extérieure de la paroi dudit tube se trouve un revêtement en forme de bande qui comporte un premier matériau élémentaire électriquement conducteur et un deuxième matériau contrariant l'évaporateur du premier matériau dudit revêtement, qu'au moins une partie du premier matériau est en contact direct avec l'oxyde d'aluminium et que pratiquement sur toute sa longueur, le revêtement en forme de bande est fixé au tube à décharge et appartient, en fonctionnement, à un dispositif auxiliaire d'amorçage pour l'amorçage d'une décharge entre les électrodes principales, caractérisée en ce que le revêtement en forme de bande couvre pratiquement toute la distance entre les électrodes principales, qui, sur au moins 90% de sa longueur, ce revêtement en forme de bande a une largeur inférieure à 0,5 mm, et que le premier matériau du

revêtement en forme de bande contient, en volume, 16% à 90% d'un élément appartenant au groupe comportant le molybdène, le tungstène, le tantale, le niobium et le carbone, alors que le deuxième matériau de ce revêtement consiste au moins en un ou plusieurs oxydes dont la tension de vapeur, à une température de 1500° Kelvin, est inférieure à  $1,3 \cdot 10^{-4}$  Pa.

2. Lampe selon la revendication 1, caractérisée en ce que le premier matériau est du molybdène ou du carbone, et en ce qu'il est réparti uniformément dans l'autre matériau du revêtement en forme de bande.

3. Lampe selon la revendication 2, caractérisée en ce qu'en volume, le revêtement en forme de bande contient environ 80% de molybdène, 10% de  $Al_2O_3$  et 10% de CaO.

4. Lampe selon l'une quelconque des revendications 1 à 3, cette lampe étant de type à décharge dans la vapeur de sodium à haute pression, le tube à décharge contenant du sodium et du xénon, la pression de remplissage du xénon étant supérieure à 6,7 kPa, caractérisée en ce que la circonférence de la section transversale du tube est comprise entre 10 mm et 40 mm.

5. Lampe selon l'une quelconque des revendications 1 à 4, caractérisée en ce que le revêtement en forme de bande est connecté électriquement à l'une des électrodes principales du tube à décharge.

35

40

45

50

55

60

65

